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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/783,247

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Jianxing Li

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11/02/2005

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EXAMINER

NOVACEK, CHRISTY L

ART UNIT

PAPER NUMBER

2822

DATE MAILED: 11/02/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/783,247	Applicant(s) LI ET AL.	
	Examiner Christy L. Novacek	Art Unit 2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 August 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 171-184 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 171-184 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>8/11/05</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This office action is in response to the amendment filed August 11, 2005.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 171-184 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claims 171 and 181, as amended, recite the limitations of forming a thin film of titanium, nitrogen and a third element that may be cobalt, nickel, phosphorus or sulfur. The specification and claims, as originally filed, recite that the third element must have at least one of the following characteristics: “(1) a standard electrode potential of less than about $-1.0V$; (2) a melting temperature of at least about $2400^{\circ}C$; and (3) at least an 8 percent difference in the atomic radii relative to titanium.” According to Table 1 of Applicant’s specification, cobalt, nickel, phosphorus and sulfur do not have any of these recited characteristics. Therefore, the specification and claims, as originally filed, do not support the limitations of forming a titanium nitride alloy including cobalt, nickel, phosphorus or sulfur.

Claim Rejections - 35 USC § 102

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The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 171, 172 and 174-179 are rejected under 35 U.S.C. 102(b) as being anticipated by Okamoto (US 5,736,192).

Regarding claim 171, Okamoto discloses a thin film of TiSiN that is formed by sputtering a TiSi target in a nitrogen atmosphere (col. 7, ln. 20-40). The thin film serves to inhibit metal diffusion from a metal-containing material (col. 7, ln. 32-35).

Regarding claim 172, Okamoto discloses that the metal-containing layer is copper (col. 7, ln. 32-35).

Regarding claim 174, Okamoto discloses that the thin film has a thickness of 10-50 nm (col. 7, ln. 20-22).

Regarding claim 175, Okamoto does not specifically disclose the electrical resistivity of the TiSiN film. However, because the thin film of Okamoto is formed of the same composition and is deposited in the same way as the thin film recited by Applicant, it appears that the thin film of Okamoto would inherently possess the function of having an electrical resistivity of equal to or less than $300 \mu\Omega\cdot\text{cm}$. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) “where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on”); and *In*

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re Fitzgerald, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 176, Okamoto discloses that the TiAlN film is used as a Cu barrier layer in a microelectronic device (col. 1, ln. 1 – col. 2, ln. 25).

Regarding claims 177-179, Okamoto discloses exposing the thin film to a temperature of 450-600°C for 20-60 minutes (col. 7, ln. 36-40). Okamoto does not specifically disclose the mean grain size of the TiSiN film. However, because the thin film of Okamoto is formed of the same composition and is deposited in the same way as the thin film recited by Applicant, it appears that the thin film of Okamoto would inherently possess the function of having a mean grain size of less than 1 nm. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) “where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on”); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Claim Rejections - 35 USC § 103

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The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 173 and 180 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okamoto (US 5,736,192).

Regarding claim 173, Okamoto does not disclose the stoichiometric ratios of the Ti, Si and N in the TiSiN layer. However, At the time of the invention, it would have been obvious to one of ordinary skill in the art to use routine experimentation to determine the optimal stoichiometric ratios of which to form the TiSiN layer of Okamoto, depending upon the thickness of the layer and its desired barrier properties because such variables of art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955).

Regarding claim 180, Okamoto discloses a material supported by a substrate into which diffusion of metal is to be alleviated, a mass over the material including the metal, an intervening layer of TiSiN between the mass and the material into which diffusion of the metal is to be alleviated, and the intervening layer alleviating diffusion of the metal from the mass to the material relative to an amount of diffusion that would occur without the intervening layer (col. 7, ln. 63 – col. 8, ln. 28). Okamoto discloses that this construction is part of a semiconductor device, but Okamoto does not specifically state that the substrate is made of a semiconductor. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use a semiconductor substrate to make the semiconductor device of Okamoto because semiconductor substrates are the most widely used and known materials on which to construct semiconductor devices.

Claims 171-184 are rejected under 35 U.S.C. 103(a) as being unpatentable over McTeer (US 5,939,788, previously cited) in view of Tregilgas et al. (US 5,942,054).

Regarding claim 171, McTeer discloses a thin film of TiAlN (2) that inhibits metal diffusion from a metal-containing material (3). The TiAlN film is formed by sputtering a TiAl sputtering target in a nitrogen atmosphere (Fig. 1; col. 17, ln. 37-53). McTeer does not disclose that the TiAlN film and the target have any additional elements therein. Like McTeer, Tregilgas discloses sputtering a TiAlN metallization film for use in an integrated circuit. Tregilgas teaches that it is advantageous to add elements such as silicon, boron and carbon to the metallization film in order to stabilize the alloy film (col. 6, ln. 12-16). Tregilgas also states that it is beneficial to add elements such as magnesium and titanium to the alloy film in order to form intermetallic compounds which increase the strength of the metallization (col. 6, ln. 17-22). At the time of the invention, it would have been obvious to one of ordinary skill in the art to add an element such as silicon, boron, carbon or magnesium to the TiAlN film and the target of McTeer because Tregilgas teaches that these elements offer the benefits of increased stabilization and strength to a thin film of TiAlN.

Regarding claim 172, McTeer discloses that the metal-containing layer includes copper (col. 17, ln. 37-53).

Regarding claim 173, McTeer discloses that the TiAlN film has a composition of 35-45% Ti, 5-15% Al and 45-55% N (col. 17, ln. 37-53).

Regarding claim 174, McTeer discloses that the TiAlN film has a thickness of 200-500 Angstroms (20-50 nm) (col. 17, ln. 37-53).

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Regarding claim 175, McTeer does not specifically disclose the electrical resistivity of the TiAlN film. However, because the thin film of McTeer, modified as suggested by Tregilgas, is formed of the same composition and is deposited in the same way as the thin film recited by Applicant, it appears that the thin film of McTeer, modified as suggested by Tregilgas, would inherently possess the function of having an electrical resistivity of equal to or less than $300 \mu\Omega\cdot\text{cm}$. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) “where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on ”); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 176, McTeer discloses that the TiAlN film is used as a Cu barrier layer in a microelectronic device (col. 17, ln. 37-53).

Regarding claims 177-179, McTeer does not specifically disclose the mean grain size of the TiAlN film. However, because the thin film of McTeer, modified as suggested by Tregilgas, is formed of the same composition and is deposited in the same way as the thin film recited by Applicant, it appears that the thin film of McTeer, modified as suggested by Tregilgas, would inherently possess the function of having a mean grain size of less than 1 nm. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) “where the Patent Office

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has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on ”); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 180, McTeer discloses a semiconductor substrate, a material (1) supported by the semiconductor substrate into which diffusion of a metal is to be alleviated, a mass including the metal formed over the material, and an intervening layer of a TiAlN thin film formed between the mass and the material into which diffusion of metal is to be alleviated, with the intervening layer alleviating diffusion of the metal from the mass to the material relative to an amount of diffusion that would occur without the intervening layer.

Regarding claim 181, McTeer discloses a thin film of TiAlNO (2) that inhibits copper diffusion from a copper-containing material (3). The TiAlNO film is formed by sputtering a TiAl sputtering target in a nitrogen atmosphere (Fig. 1; col. 17, ln. 37-63). McTeer does not disclose that the TiAlNO film and the target have any additional elements therein. Like McTeer, Tregilgas discloses sputtering a TiAlN metallization film for use in an integrated circuit. Tregilgas teaches that it is advantageous to add elements such as silicon, boron and carbon to the metallization film in order to stabilize the alloy film (col. 6, ln. 12-16). Tregilgas also states that it is beneficial to add elements such as magnesium and titanium to the alloy film in order to form intermetallic compounds which increase the strength of the metallization (col. 6, ln. 17-22). At

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the time of the invention, it would have been obvious to one of ordinary skill in the art to add an element such as silicon, boron, carbon or magnesium to the TiAlNO film and the target of McTeer because Tregilgas teaches that these elements offer the benefits of increased stabilization and strength to a thin film of TiAlN.

Regarding claim 182, McTeer discloses a TiAlN layer having the composition of 35-45% Ti, 5-15% Al and 45-55% N that is doped with oxygen, but McTeer does not disclose how much oxygen is doped into the layer. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use routine experimentation to determine an optimal amount of oxygen to dope into the TiAlN layer of McTeer, depending upon the thickness of the TiAlN layer and the amount of resistivity to diffusion required, because such variables of art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955).

Regarding claims 183 and 184, McTeer discloses that the thin film includes aluminum.

Response to Arguments

Applicant's arguments with respect to claims 171-182 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christy L. Novacek whose telephone number is (571) 272-1839. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CLN
October 27, 2005

